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CONVERT ELECTRIC BOILERS TO NATURAL GAS AND SAVE DOLLARS

The Facts...

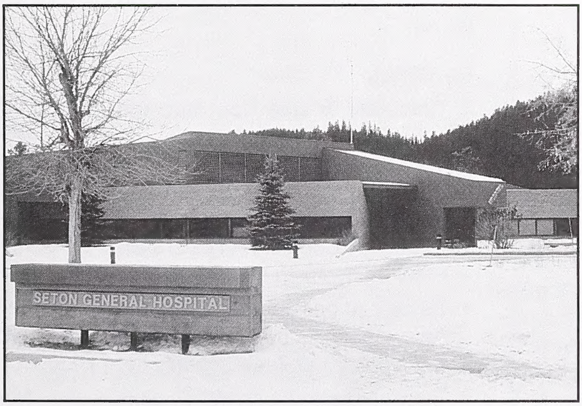
One important criteria to consider when selecting boiler equipment is the type of fuel to be used. The result can be significant variations in operating costs. In Alberta, the average electricity cost for most facilities can range from three to nine times that for natural gas. Utility rates should be carefully examined to determine the electrical demand charge and the cost per kWh of energy prior to final selection of equipment to be used.

Another factor to consider is the efficiency of natural gas and electric boilers. Electric boilers are generally more efficient than natural gas-fired units because heating electrodes are immersed in the boiler water, resulting in direct heat transfer. Heat losses, due to radiation from hot surface of the boiler, range from four to eight per cent depending on shell insulation. Thus, the efficiency of an electric boiler is approximately 92 to 96 per cent.

By comparison, there are several other efficiency reductions which occur on natural gas boilers. Because the products of combustion (ie. gases) must be vented from the building, the main loss occurs through the boiler stack. Although most heat energy is transferred to the boiler water, 15 to 25 per cent remains in the flue gases – and is lost up the stack. During off periods warm air escapes up the boiler stack cooling down the heat exchanger. Pilot lights consume gas during off periods. Radiation loss also occurs.

When all losses are considered, efficiencies range from 60 to 75 per cent for natural draft or atmospheric boilers with a standard pilot light. Boilers with forced draft combustion air fans, flue gas condensing systems and electronic pilot lights can have efficiencies closer to that of the electric boiler.

An analysis of utility and conversion costs and boiler efficiencies can determine if it is practical to convert an electric boiler to a natural gas boiler.



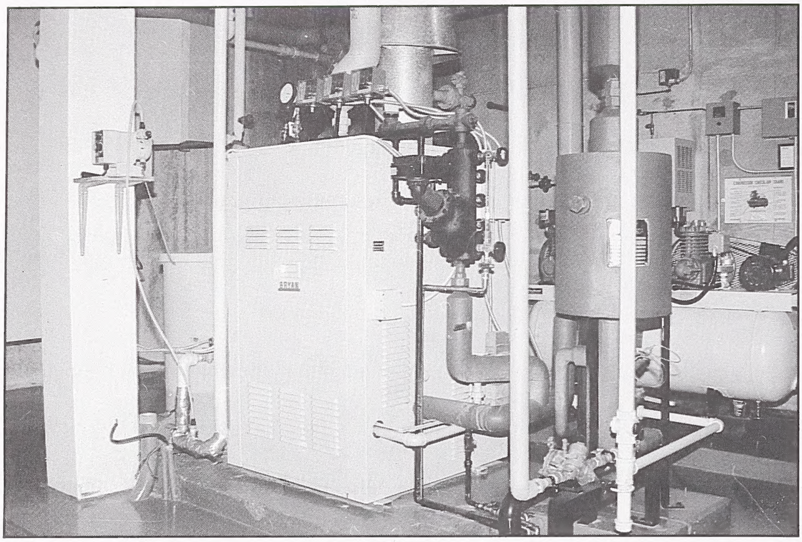
Seton General Hospital – Jasper

The Application...

Seton General Hospital in Jasper is a 33-bed single storey facility with 3900 m^2 of floor area. It was built in 1974. Staff of the Energy Efficiency Branch conducted two energy audits, the first in 1983 and the second in 1988.

One suggestion of the energy audit team was to load schedule the electric steam boiler. (In this case, load scheduling refers to operating equipment at a lower kW demand for a longer time period instead of operating at a higher kW demand for a shorter period). The boiler was used to generate steam for sterilizing units. It consisted of four heating elements with a measured load of 70 kW. With all heating elements on, boiler warm-up in the morning lasted 25 to 30 minutes. Once operating temperature was achieved, it cycled on one minute and off for five minutes. Load scheduling done with two elements disconnected showed the power draw was 35 kW. The morning warm-up cycle was longer, as expected, and after operating temperature was reached the unit cycled on for about three minutes and off for nine minutes.

It was suggested to operate the boiler with only two ele-



New natural gas steam boiler at Seton Hospital

ments to reduce the peak electrical demand costs. The savings were calculated to be some $5,000 per year. The suggestion was taken one step further by converting the 100 kW rated electric boiler to an equivalent sized 324,000 BTU/hr natural gas-fired atmospheric boiler. (The timing was excellent because the old boiler was due for a major overhaul due to leaks and scale build-up). This resulted in a savings of $10,000 per year!

Subsequent data has indicated a dramatic reduction in electrical demand. In 1990 and 1991, the maximum yearly demand dropped to 202 kW from the previous 259 kW, a total of 57 kW. Although 57 kW is less than the predicted 70 kW, normal fluctuations of electrical demand in a complex building system such as a hospital are to be expected and would likely account for the difference of 13 kW.

Installation costs were kept to a minimum because hospital maintenance staff did most of the work. As well, existing boiler accessories such as pumps and controls were incorporated into the new boiler system. Director of Maintenance Harry Ammon, says the new boiler ''operates well and not much maintenance is required.''

The cost of the boiler conversion was approximately $15,000. With annual savings of $10,000, the payback period on the modifications is calculated as follows: capital cost divided by net savings, multiplied by 12 months of the year.

$$\frac{15{,}000}{10{,}000} \times 12 = 18 \text{ months}$$

The Bottom Line ...

The example of the Seton General Hospital shows that fuel conversion is a worthwhile cost-saving measure.

To calculate potential annual savings, building managers can use the graphs and technique described below:

EXAMPLE

1. Calculate Energy Cost Savings

a) Electric Boiler Costs

Information Needed:

- Lowest applicable electrical energy charge (Contact your local electrical utility for this information)
- Estimated boiler operating hours per week (The number of hours per week the boiler is actually on)
- Boiler output size in kW (This is shown on the boiler nameplate)

Using figure 1, draw a vertical line from hours per week on and intersect with the lowest applicable energy charge. Then draw a horizontal line across to determine the annual energy cost. The broken green line shows an example. Assuming 40 hours per week boiler-on time and three cents per kW•h as the lowest applicable energy charge, the annual cost is estimated to be $6,600 for a 100 kW boiler. If the boiler is a different size than 100 kW then divide the actual boiler size by 100 kW and multiply by the estimated annual cost of $6,600 to correct the annual cost for the actual boiler.

Using the above example:

$$\frac{120 \text{ kW}}{100 \text{ kW}} \times \$6{,}600 = \$7{,}920 \text{ per year}$$

Note: Figure 1 is based on a boiler efficiency of 94 per cent.

b) Natural Gas Boiler Costs

Information Needed:

- Natural gas energy charge (Contact your local natural gas utility for this information)
- Most natural gas boilers are rated in British Thermal Units per hour (BTU's per hour). Therefore, the equivalent size natural gas boiler must be determined in BTU's per hour. To calculate, simply multiply the electric boiler kW size by 3414. For example:

$$120 \text{ kW} \times \frac{3414 \text{ BTU's per hour}}{\text{kW}} = 409{,}680 \text{ BTU's per hour}$$

Assuming a natural gas cost of $2.50 per GJ and 40 hours per week boiler-on time use the same procedure for Figure 2 as with Figure 1 to determine annual costs for a 341,400 BTU's per hour boiler of $2,700. Next correct the annual cost for a 409,680 BTU per hour boiler.

$$\frac{409{,}680 \text{ BTU's per hour}}{341{,}400 \text{ BTU's per hour}} \times 2{,}700 = \$3{,}240 \text{ per year}$$

Note: Figure 2 is based on a boiler efficiency of 70 per cent.

c) Calculate differential of energy costs

Electric Boiler Energy Cost	$7,920
Natural Gas Boiler Energy Cost	$3,240
Difference	$4,680

2. Calculate Electrical Demand Savings

Contact your local electric utility for the applicable electrical demand charge. In this example, $12 per kW per month is used. If the boiler is on for up to 15 minutes during regular operating hours, it is likely that demand savings will apply. (An electrical demand load profile would confirm if the boiler is operating during peak demand periods. Utility companies and consultants can provide this service.) To calculate savings multiply the boiler input rating in kW by the demand charge and the number of months per year the boiler is used. The boiler input rating should be shown on the boiler nameplate and should be slightly higher than the output rating. If it is not shown, divide the output rating by .94. It is best, however, to take actual measurements of input amps and voltage. Use the following formula to calculate input kW: volts × amps divided by 1,000 × 1.732)

EXAMPLE

$12 per kW per month × 12 months per year × 120 kW divided by .94 = $18,383 per year

$$\frac{12 \times 12 \times 120}{.94} = \$18{,}383 \text{ per year}$$

3. Calculate Total Annual Savings

Demand Savings	18,383
Energy Cost Differential Savings	+ 4,680
Total Savings	$23,063

4. Determine Simple Payback

Divide the yearly savings into the cost of conversion and multiply by 12 months to calculate the number of months' payback.

EXAMPLE

- Cost of Conversion $20,000
- Yearly Savings $23,063

$$\frac{\$20{,}000}{23{,}063} \times 12 \text{ months per year} = 10.4 \text{ months' payback period}$$

FIGURE 1

Energy Cost of a 100 kW Electric Boiler

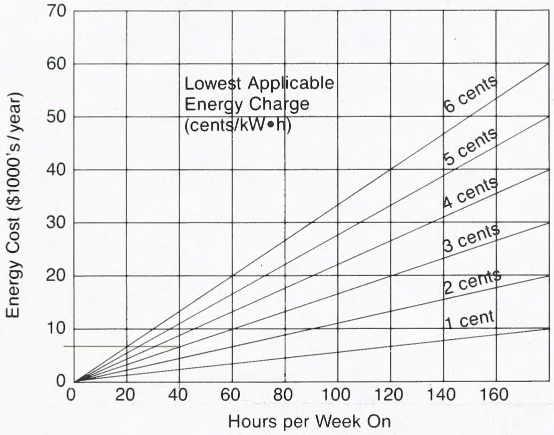
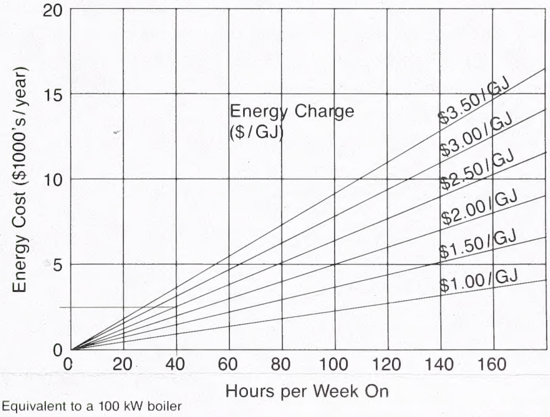


FIGURE 2

Energy Cost
341,400 BTU's Per Hour Natural Gas Boiler*



* Equivalent to a 100 kW boiler

SECTOR REVIEW

Savings Potential in Active Care Hospitals...

Energy use varies widely, depending on the type of building and the activities in the building. Variations in energy use are evident following Energy Bus audits of almost every type of facility.

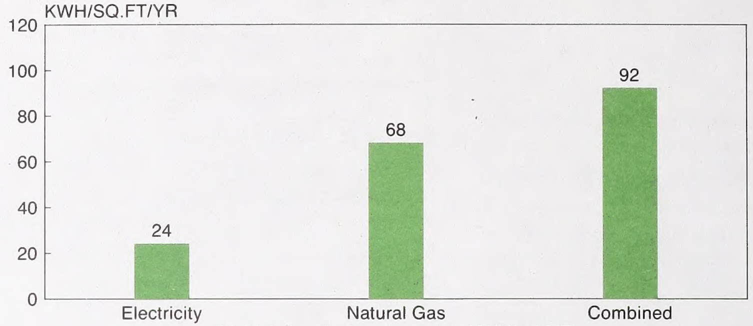
An energy audit determines how energy is being used and how much it costs in each area. Energy efficiency measures are then identified which may result in energy cost savings. Based on 42 hospitals audited, the Energy Bus team has identified potential savings of about 21 per cent.

Figure 3 shows energy use for active care hospitals. In this analysis, an annual energy usage based on building floor area is indicated for natural gas, electricity, and combined electricity and natural gas.

Figure 4 compares energy use and cost. In Alberta, natural gas is the least expensive form of energy. For active care hospitals the average price of a unit of electrical energy is 4.5 times that of an equivalent unit of natural gas (based on the 42 hospitals audited).

Energy Bus audits have identified considerable potential for fuel conversion savings at 22 hospitals. Fuel conversion represents 14 per cent savings on the total electrical savings potential as shown in Figure 5.

FIGURE 3 **Energy Use – Active Care Hospitals**



(Multiply by 10.76 to convert to KWH/m2/YR)

FIGURE 4 **Active Care Hospitals Energy Use and Cost**

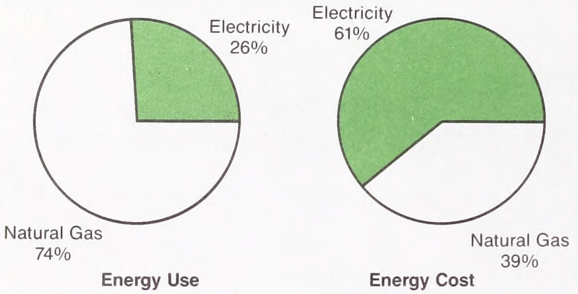
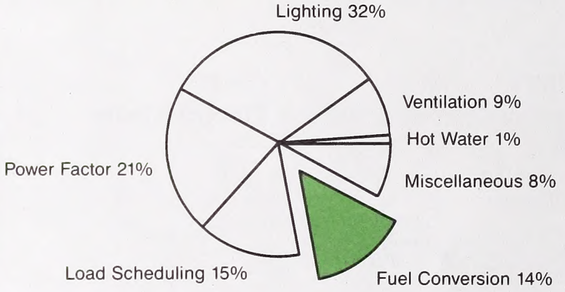
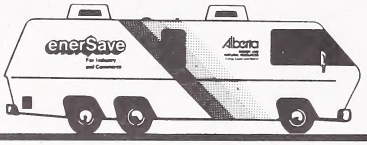


FIGURE 5 **Potential Electrical Savings**



FOR MORE INFORMATION

The article *Convert Electric Boilers to Natural Gas and Save Dollars* was researched by David Supruniuk. The Energy Efficiency Branch gratefully acknowledges the editorial reviews done by Jim Thurston, Gladwall Engineering Services Limited; Dave Brown, former director of maintenance, Seton Hospital; and Harry Ammom, current director of maintenance, Seton Hospital. For detailed information on energy cost-saving calculations and the energy audit database, contact the technical services section of the Energy Efficiency Branch: Phone 427-5200 (collect).



ENERGY $AVER$

Energy $aver$ is a series of fact sheets about energy efficiency measures that have wide application in Alberta. Each issue highlights a different technology and its successful use in the province. The Sector Review summarizes energy use patterns of different facilities that have used Alberta's Energy Bus audit service. Comments, questions, and suggestions are welcome.

Write or phone (collect) to be placed on the mailing list. You may also receive back issues or arrange for an Energy Bus audit (conducted at no charge).

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